Evaluation of intake modifications at Bonneville Dam Second Powerhouse, 2001

Fish Ecology Division

Northwest Fisheries Science Center

National Marine Fisheries Service

Seattle, Washington

by
Bruce H. Monk, Randall F. Absolon,
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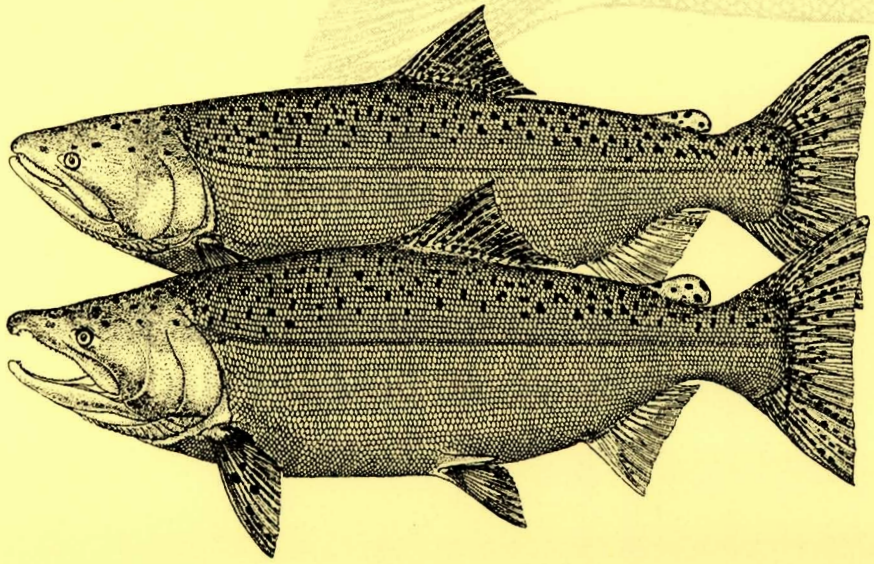

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Report of Research by

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Northwest Fisheries Science Center
National Marine Fisheries Service
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EXECUTIVE SUMMARY

In 1999, National Marine Fisheries Service studies of existing fish-guidance, biological, and hydraulic-model data concluded that flow conditions at Bonneville Dam Second Powerhouse were not conducive to high fish guidance efficiency (FGE) because of inadequate flow entering the gatewell above the submersible traveling screen (STS). From these studies, the following three modifications were proposed to increase flow from the turbine intakes into the gatewell:

1) Remove a section of concrete beam to extend the vertical barrier screen (VBS);

2) Attach a turning vane to the STS; and

3) Install a gap closure device on the ceiling intake just downstream from the top edge of the STS.

Model studies with these changes in place measured gatewell flows of 13.6 m^3/s and a corresponding gap flow of 2.5 m^3/s. In the spring of 2001, these three modifications were completed in the B and C gatewells of Unit 15. In the A gatewell, a larger VBS and turning vane were installed, but the gap closure device was not installed. Fish guidance efficiency tests were conducted in the B gatewell.

During spring testing, FGE averaged 71% for yearling chinook salmon and over 80% for steelhead and coho, the highest FGE values measured at Bonneville Dam Second Powerhouse since testing began in the early 1980s. These values were 15-33% higher than comparable values measured in Unit 15 in 1994. During summer testing, FGE for subyearling chinook averaged 57%, which was 17% higher than earlier measurements.

Orifice passage efficiency (OPE) tests were conducted during the same period. These tests measured the percent of yearling chinook salmon and subyearling chinook salmon that exited from the gatewell via the orifice during a 17-hour period. Orifice passage efficiency was 94% for yearling chinook salmon in the spring and 99% for subyearling chinook salmon in the summer.

All fish in the OPE tests were PIT tagged so that passage times from release in the gatewell to the detectors at the Smolt Monitoring Facility downstream could be measured. In the 10 replicate tests, median passage times averaged 1.6 and 0.8 hours for yearling chinook and subyearling chinook salmon, respectively. For each species there were no significant differences in either OPE or passage between Gatewells 15B and 16B (an unmodified unit).

During both FGE and OPE tests, descaling and injury rates were low for all species sampled. During spring testing, average descaling rates ranged from 2 to 3% for all species, with no significant differences between the modified and unmodified unit and no differences between units with and without the gap closure device. During summer testing, descaling rates for subyearling chinook salmon were 2% or less in both the modified and unmodified units, with no significant difference between units.

Based on these favorable results, further testing of these intake modifications in additional units is warranted to characterize results across the entire powerhouse.

CONTENTS

INTRODUCTION

In 1970, in response to concerns over the effect additional dams may have on juvenile Pacific salmon *Oncorhynchus* spp. during their seaward migration, the National Marine Fisheries Service (NMFS) began investigating means to decrease impacts to juvenile salmonids passing through Columbia River dams (Whitney et al. 1997). NMFS focused on developing submersible traveling screens (STSs) that divert juvenile salmon migrants out of the turbine intakes and into specially designed bypass systems.

These bypass systems convey the guided fish to release points below the dam (Mathews et al. 1977). The performance of the STS was measured by fish guidance efficiency (FGE) tests, which measure the percentage of fish guided into the bypass system by the STS relative to the total number of fish entering the turbine intake.

Bonneville Dam Second Powerhouse was completed in 1982, and NMFS began estimating FGE at this facility in 1983. Initial measurements of FGE with standard-length STSs (6.1 m) were less than 25% for yearling chinook *O. tshawytscha* and coho salmon *O. kisutch* and were approximately 33% for steelhead *O. mykiss*. These guidance levels were considerably lower than the expected design level of 70% or greater for all species (Krcma et al. 1984).

From 1984 to 1989, the U.S. Army Corps of Engineers (COE) and NMFS tested various design modifications to improve FGE at Bonneville Dam Second Powerhouse. The results indicated that modifications to increase flows above the STS and to smooth flows into and within the turbine intake during the spring migration could substantially increase FGE for yearling chinook salmon (Gessel et al. 1991). Tests in 1985 showed that lowering the STS 0.8 m, in conjunction with streamlining the trash racks, increased FGE to about 40% and the gap-net catch (percent of fish escaping over the top of STS back into the intake) remained at less than 1%.

However, lowering the STS 1.2 m increased the gap-net catch to 12% and reduced FGE to 29% (Gessel et al. 1986). From 1987 to 1989, FGE ranged from 51 to 74% (in 4- to 5-day test series) in Turbine Units 11, 12, and 13, with STSs lowered 0.8 m, streamlined trash racks, and turbine intake extensions (TIEs). Based on these results, the STSs were lowered 0.8 m, streamlined trash racks were installed across the powerhouse, and TIEs were installed in alternating intake slots in 1991 (Fig 1).

In 1993 and 1994, FGE was again measured at Bonneville Dam Second Powerhouse (Monk et al. 1994, 1995). In these tests, FGE averaged 57% for yearling chinook salmon in Unit 15 with all eight turbine units in operation. With the six highest priority units in operation (Units 11-13, 16-18) FGE averaged 53 and 32% for yearling

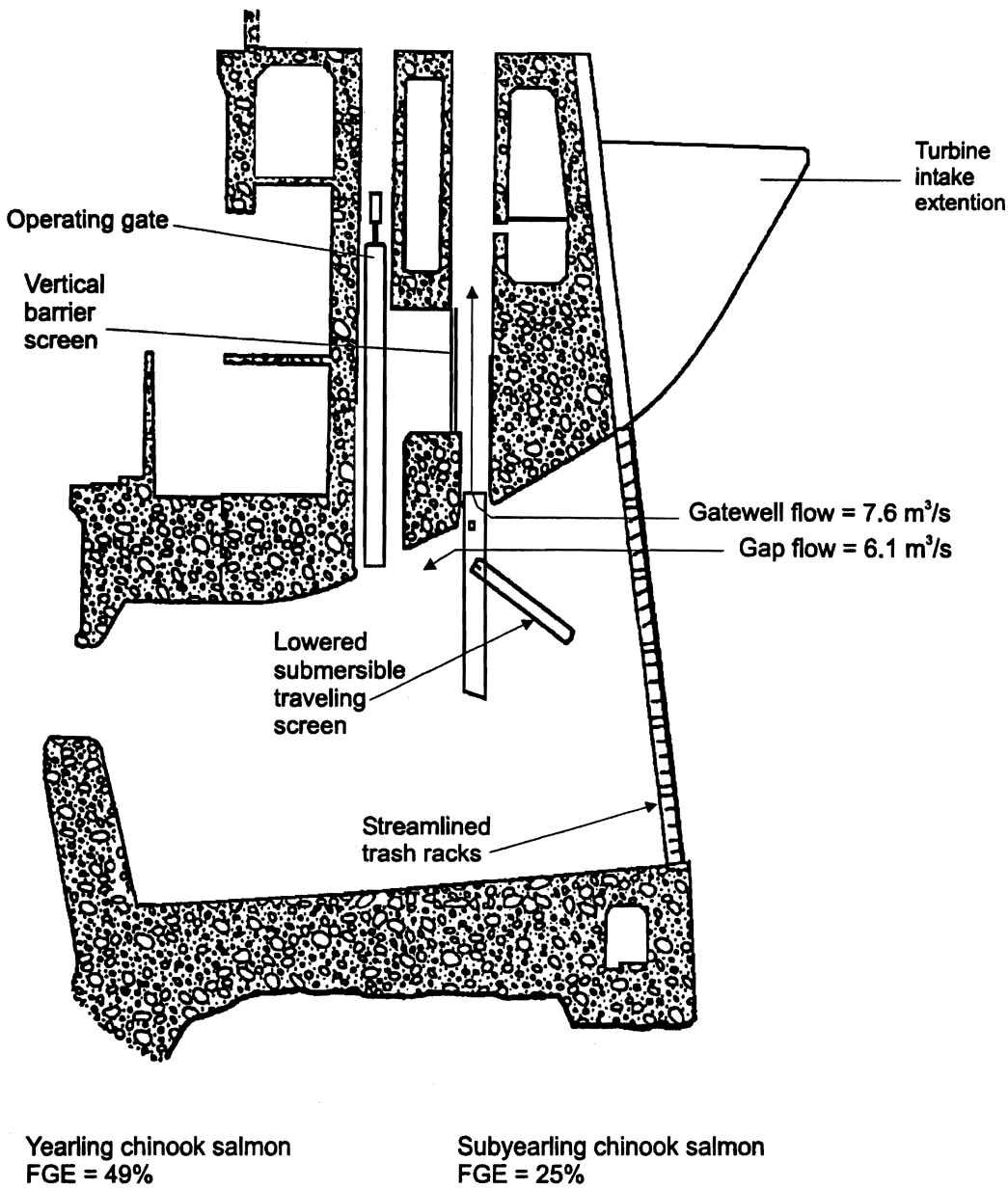


Figure 1. Cross section of standard turbine unit prior at Bonneville Dam Second Powerhouse prior to modifications during 2001. Flow and fish guidance efficiency are averaged across the powerhouse.

chinook salmon in Units 12 and 17, respectively. During these tests the average gap-net catch for all species combined was less than 1%.

In 1999, NMFS reviewed all biological and hydraulic data collected between 1983 and 1998 at Bonneville Dam Second Powerhouse with respect to improving FGE (Monk et al. 1999a). To better understand the reasons for low FGE at the second powerhouse, the intake design was compared to intake designs at other Columbia River dams where FGEs are higher. Differences were noted in forebay hydraulics, configurations of the intake structure, and components of the fish bypass systems, all of which seemed to contribute to lower FGE at the second powerhouse.

The report concluded that intake flow conditions at the second powerhouse were not conducive to high fish guidance because of hydraulic constraints leading to reduced flow in the area above the STS leading to the gatewell. The report recommended that efforts to improve FGE at the second powerhouse should focus on increasing flow into the gatewell, and that these flows would need to be 8.0 m^3/s (284 ft^3/s) or greater to be effective.

In a follow-up to this report, hydraulic model studies of the Bonneville Dam Second Powerhouse intake were conducted in the spring and summer of 2000 at the COE's Engineering Research and Development Center (ERDC) in Vicksburg, Mississippi and at ENSR Consultants in Redmond, Washington. These studies measured flows of 7.6 m^3/s (270 ft^3/s) in the gatewell slot with corresponding gap flows of 6.1 m^3/s (215 ft^3/s) over the top of the STS. This high percentage (44%) of flow through the throat area of the STS indicated that the potential for loss of fish through the gap was substantially larger than that actually measured during previous FGE studies.

To address these issues, three modifications were proposed to increase flow from the turbine intakes into the gatewell: 1) increase the length of the vertical barrier screen (VBS) by removing a portion of the concrete beam below it; 2) install a turning vane below the picking beam on the STS; and 3) install a gap closure device on the intake ceiling downstream from the top edge of the STS (Fig. 2; Inca 1999).

To meet new design criteria for salmonid fry established by NMFS, screen mesh openings on the new VBS were decreased to 0.08 in, with a porosity of 44%. These proposed modifications, as well as an extended VBS, were tested in hydraulic models at ERDC and ENSR. Results indicated gatewell flow increased to 13.6 m^3/s (480 ft^3/s) and corresponding gap flow decreased to 2.5 m^3/s (90 ft^3/s).

In the spring of 2001, all three of these modifications were made in the B and C gatewells of Turbine Unit 15 to evaluate the effects on FGE. In the A gatewell, the

turning vane was attached to the STS and the larger VBS was installed, but the gap closure device was not installed. In 2001, research objectives at Bonneville Dam Second Powerhouse were:

1) Estimate FGE of a modified screen system at Bonneville Dam Second Powerhouse during spring and summer juvenile migrations.

2) Evaluate gatewell orifice passage efficiency (OPE) rates in a modified screen system unit and compare them to OPE rates in a standard unit during spring and summer migrations.

3) Evaluate effects of a modified screen system on juvenile salmonids and lamprey and compare to a standard unit during spring and summer migrations.

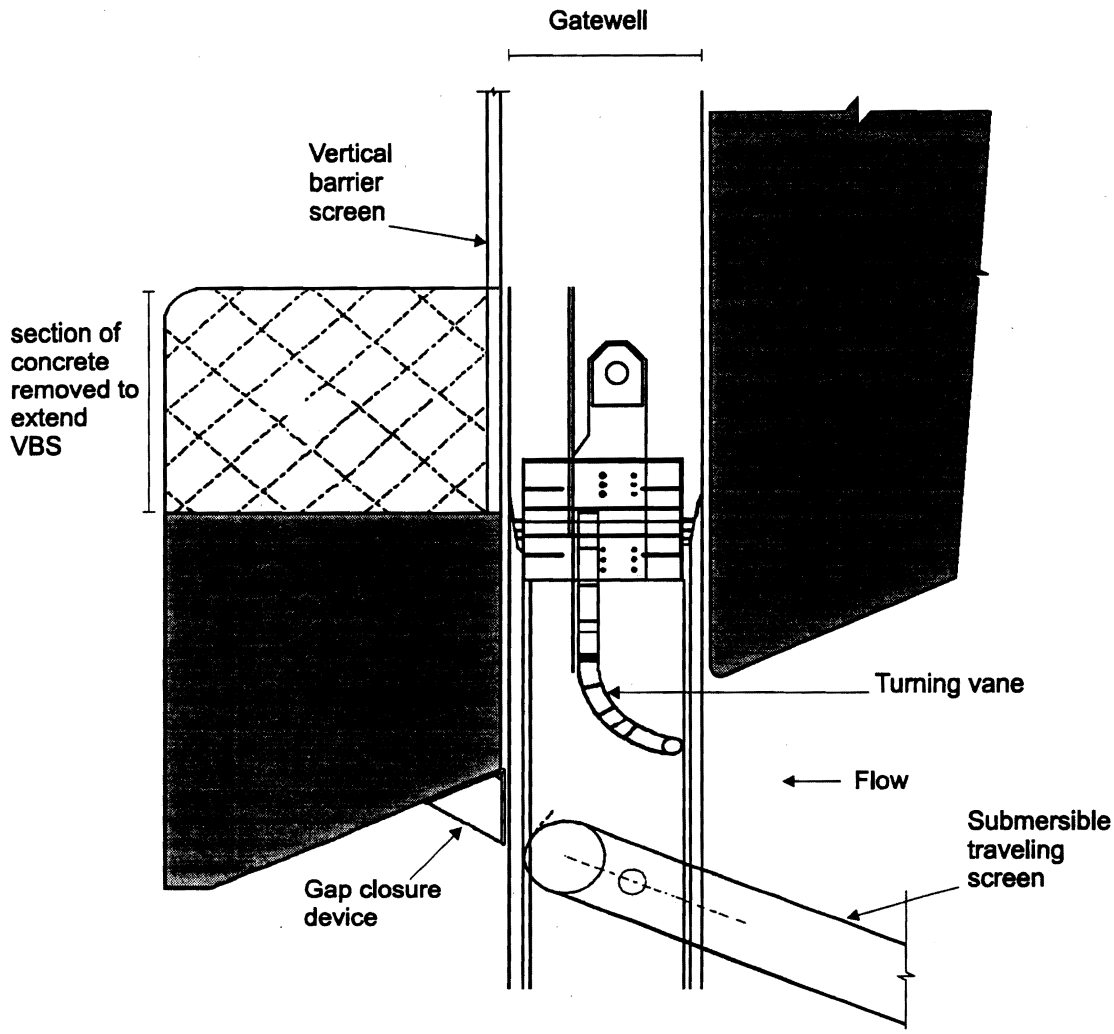


Figure 2. Cross section of Unit 15 at Bonneville Dam Second Powerhouse showing the three modifications evaluated in 2001: 1) a section of concrete beam is removed for installation of a longer vertical barrier screen, 2) a turning vane is installed, and 3) gap closure device is installed.

OBJECTIVE 1: ESTIMATE FISH GUIDANCE EFFICIENCY OF A MODIFIED SCREEN SYSTEM

Approach

All tests for estimating FGE were conducted in the B gatewell of Unit 15. The methods for determining FGE were the same as those used in previous STS studies (Monk et al. 1994, 1995; Gessel et al. 1991). A fyke-net frame with an array of nets was hung under the STS and gap nets, and closure nets were used to close off the area directly above and below the STS (Fig. 3). Gatewell dip-net catches provided the number of guided fish and fyke-net catches provided the number of unguided fish. The FGE for each species was calculated as gatewell catch (guided fish) divided by the total number of fish (guided plus unguided) passing through the intake during the test period.

$$FGE = \frac{GW}{(GW + FN)} \times 100\%$$

$$GW = \textit{Gatewell catch}$$
$$FN = \textit{Fyke-net catch}$$

During spring and summer testing, each test was started at 2000 and ended when approximately 200 of the target species had been collected (21:30-22:30). To determine if turbine unit operational mode affected FGE, Unit 15 was operated under two modes: 1) high 1%, or the upper 1% of the efficiency range for a given level of head, as prescribed by COE Fish Passage Plan; and 2) automatic governing control (AGC), which balances unit load within the high 1% range across the powerhouse. These modes were used on alternating nights during both migration periods.

Results from tests using the high 1% mode were used for comparisons to results from past years, when all tests were conducted using the high 1% mode. The AGC mode was used because it is the present standard operating mode. Paired *t*-tests (paired by day) were used to compare FGE results between the two operating modes.

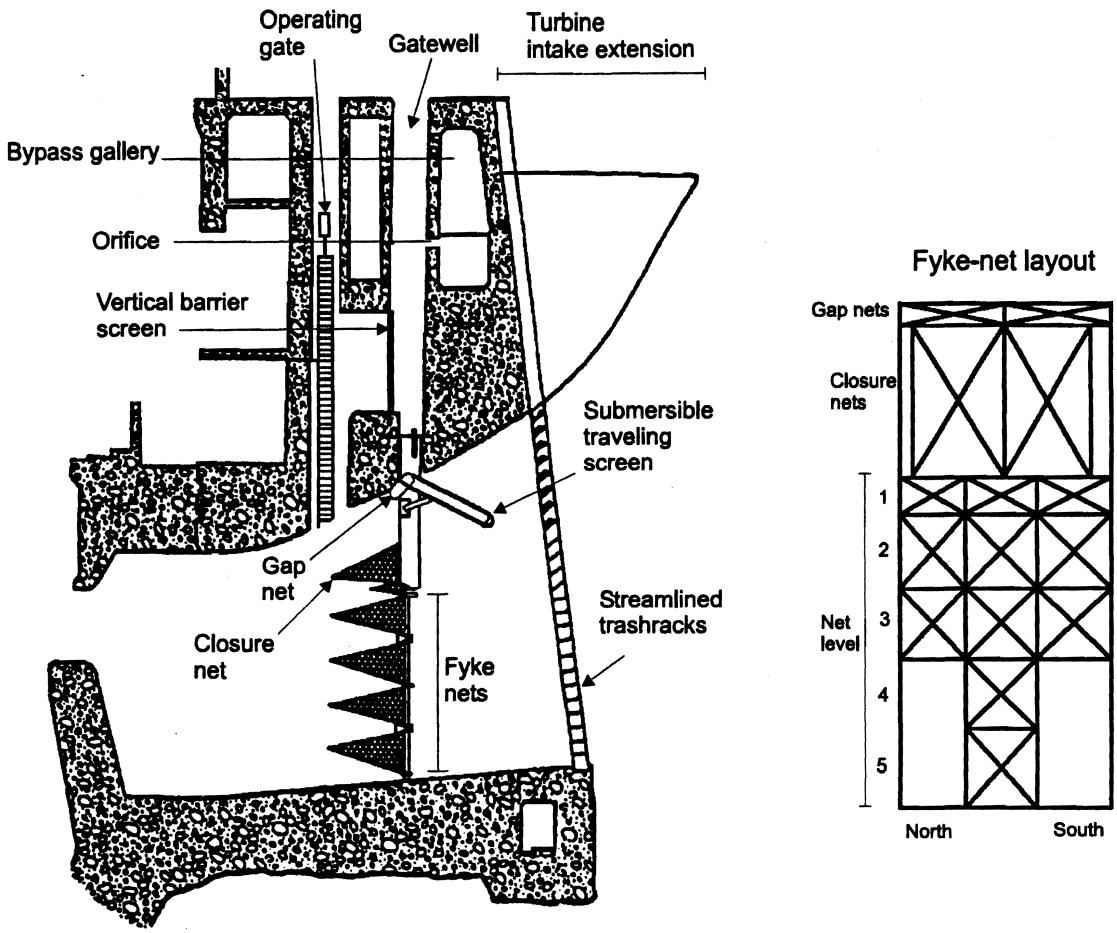


Figure 3. Cross section of turbine intake at Bonneville Dam Second Powerhouse showing layout of fyke nets used for fish guidance efficiency tests.

Results and Discussion

Spring Testing

From 24 April to 23 May, 21 FGE tests were completed. Gatewell and fyke-net catches and resulting FGE for yearling and subyearling chinook salmon, coho salmon, sockeye salmon, and steelhead are given in Appendix Table 1 for all of these tests.

For yearling chinook salmon, FGE ranged from 47 to 85% with a mean of 71% (SE = 2.5). Fish guidance efficiency for coho salmon and steelhead averaged 88% (SE = 2.4) and 82% (SE = 2.6), respectively. Because of low numbers, no estimate of FGE was calculated for sockeye salmon. Although numbers of fish were small for some of the tests, FGE for subyearling chinook averaged 63% (SE = 6).

These averages were the highest measured at the second powerhouse since testing began in 1981 and, for the first time, average FGE for all species tested (except subyearling chinook salmon) was over 70%. When compared to data collected in 1993 in Unit 15 with all eight units in operation, increases in FGE with the three modifications ranged from 2 to 33% (Table 1).

During spring, respective load and discharge levels averaged 73 MW and 448 m^3/s (15.8 kcfs) in high 1% operating mode and 65 MW and 385 m^3/s (13.6 kcfs) in AGC operating mode. Average FGEs for yearling chinook salmon were 75% at the high 1% and 74% at the AGC mode (not all 21 tests were included) with no significant differences between the two modes ($t = 0.17$, $P = 0.43$; Fig. 4).

Summer Testing

In 20 tests conducted with subyearling chinook salmon from 11 June to 12 July, FGE ranged from 30 to 71%, with a mean of 57% (SE = 3.2; Table 1). Detailed FGE results from gatewell catches and fyke-net catches are given in Appendix Table 1. In past FGE studies at the second powerhouse, FGE was not estimated in Unit 15 during the summer migration, therefore the potential increase in FGE in this unit during the summer for subyearling chinook salmon cannot be estimated. In 1993, FGE for subyearling chinook salmon during their summer migration was measured in Units 12 and 17. With four or six units in operation, FGE averaged 40% (SE = 3.5) for these two units (Table 1; Monk et al. 1994).

Table 1. Average fish guidance efficiency (FGE) and standard errors for all species tested in Unit 15 in 1994 (standard conditions) and 2001 (with all three modifications in place). Also shown is the change (Δ) in FGE between the two conditions.

	1994*		2001		
	FGE (%)	SE	FGE (%)	SE	Δ
Spring testing					
Subyearling chinook salmon	60		62	6.0	2
Yearling chinook salmon	56	4.0	71	2.5	15
Coho salmon	69	3.5	88	2.4	19
Steelhead	49	3.0	82	2.6	33
Summer testing					
Subyearling chinook salmon	40	3.5	57	3.2	17

* Averaged FGE values for spring 1994 are from Unit 15 (with a full powerhouse load). FGE values for summer comparisons for subyearling chinook salmon are averaged from 1993 results in Units 12 and 17 with partial powerhouse loading.

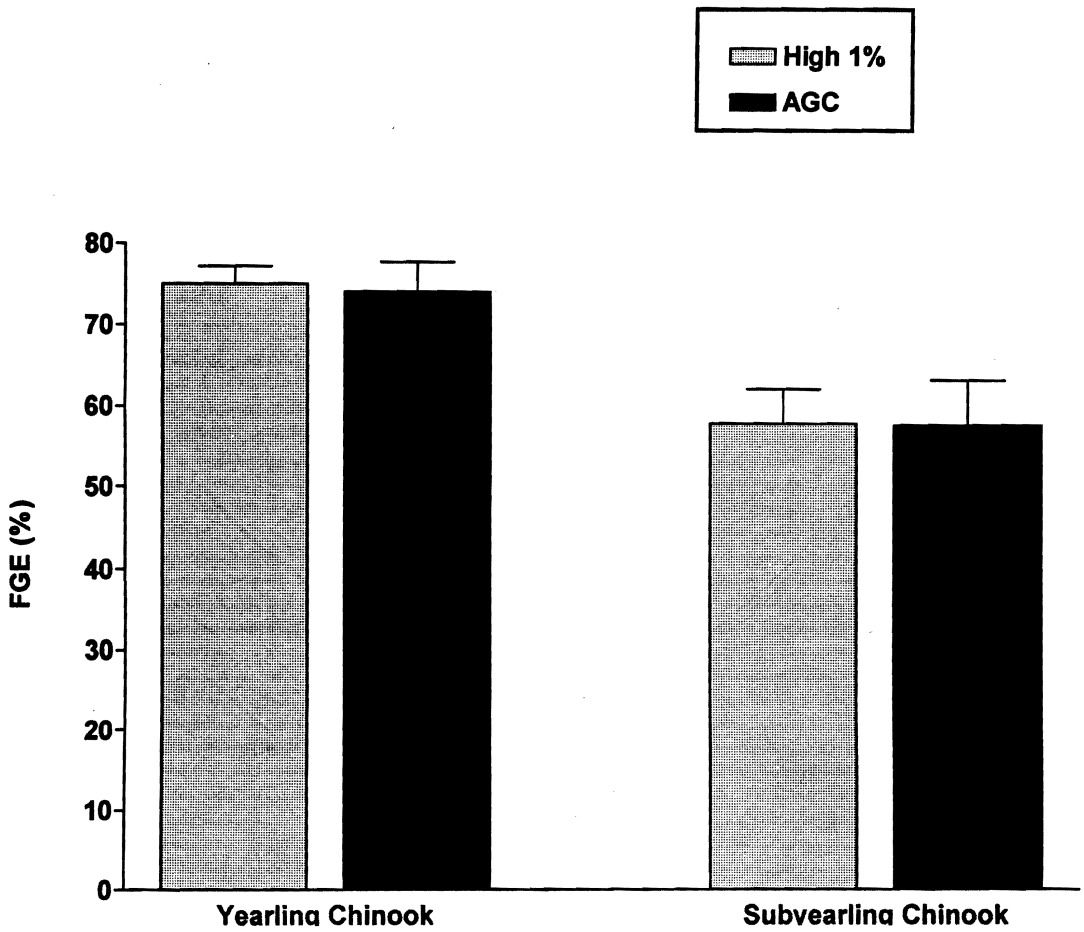


Figure 4. Fish guidance efficiency (with standard errors) for yearling chinook salmon in the spring and subyearling chinook salmon in the summer at Bonneville Dam Second Powerhouse, 2001. Tests in the B gatewell of Unit 15 were conducted in both the high 1% and automatic governing control (AGC) operating modes.

At most Columbia River Dams, FGE for subyearling chinook salmon decreases as the migration progresses. This was noted at the Bonneville Dam First Powerhouse in 1998 and 2000 (Monk et al. 1999b, Monk and Sandford 2001); however, this did not seem to be the case this year at the second powerhouse in Unit 15. Although there was a large range of FGE values, there was no correlation between date and change in FGE (Fig. 5).

During the summer, load and discharge levels averaged 74 MW and 441 m^3/s (15.6 kcfs) in the high 1% operating mode and 65 MW and 391 m^3/s (13.8 kcfs) in the AGC operating mode (standard condition). Average FGE for subyearling chinook salmon was 57% at both operating modes (not all 20 tests included; Fig. 4).

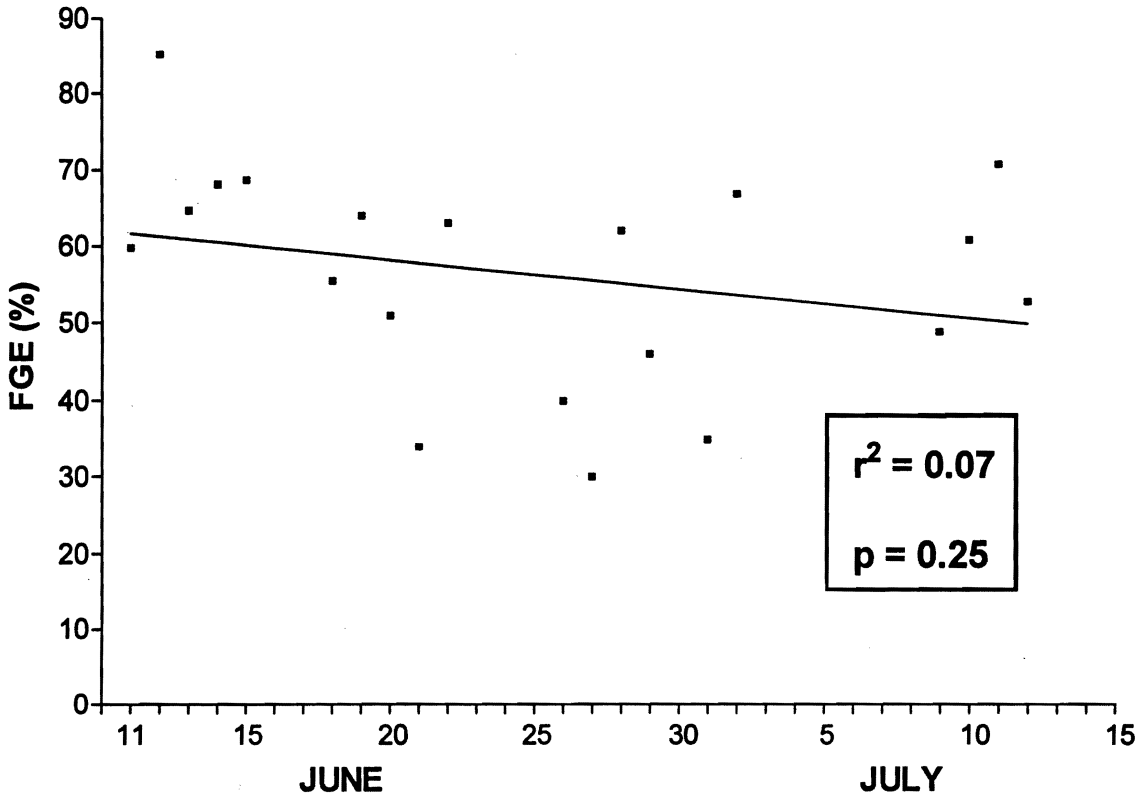


Figure 5. Fish guidance efficiency for subyearling chinook salmon during summer 2001 correlated with date.

OBJECTIVE 2: COMPARE ORIFICE PASSAGE EFFICIENCY BETWEEN A MODIFIED SCREEN SYSTEM AND A STANDARD UNIT

Approach

To conduct OPE tests, groups of 200 juvenile salmon (yearling chinook salmon in the spring and subyearling chinook salmon in the summer) were anesthetized, PIT-tagged, held for approximately 5 hours, and released into gatewell slots 15B (modified unit) and 16B (standard unit) at approximately 2300 (100 fish released into each gatewell). A 240-L (63 gal.) aluminum canister (Absolon and Brege in press) was used to lower the fish 4.6 m (15 ft) below the orifice at elevation 14 m (45 ft) msl.

All releases were made with the units operating and the orifices open. During the tests, both units were operated on AGC, and an effort was made to maintain similar discharge between the two units for the duration of the test. After 17 hours, all fish were removed from both gatewells and the number of remaining PIT-tagged fish counted. The OPE was calculated as the percentage of PIT-tagged fish that exited the gatewell during the 17-hour test.

The separation-by-code system at the second powerhouse Smolt Monitoring Facility was used to sort fish PIT-tagged for OPE tests as they came through the bypass system. Passage times from release in the gatewell to detection at the monitoring facility were also calculated for both release groups. Paired *t*-tests (paired by day) were used to compare both OPE and passage time between the modified and standard units

Results and Discussion

Spring Testing

From 24 April to 17 May, 11 OPE replicates were conducted in the B gatewells of Units 15 and 16. OPE for yearling chinook salmon ranged from 82 to 100% with an average of 94% (SE = 2.5) in Unit 15 and from 93 to 100% with an average of 97% (SE = 1.6) in Unit 16. The average median passage times were 1.6 and 1.4 hours for units 15 and 16, respectively (Fig. 6). There were no significant differences in either OPE ($t = 0.88$, $P = 0.39$) or passage time ($t = 0.16$, $P = 0.43$) between the two units.

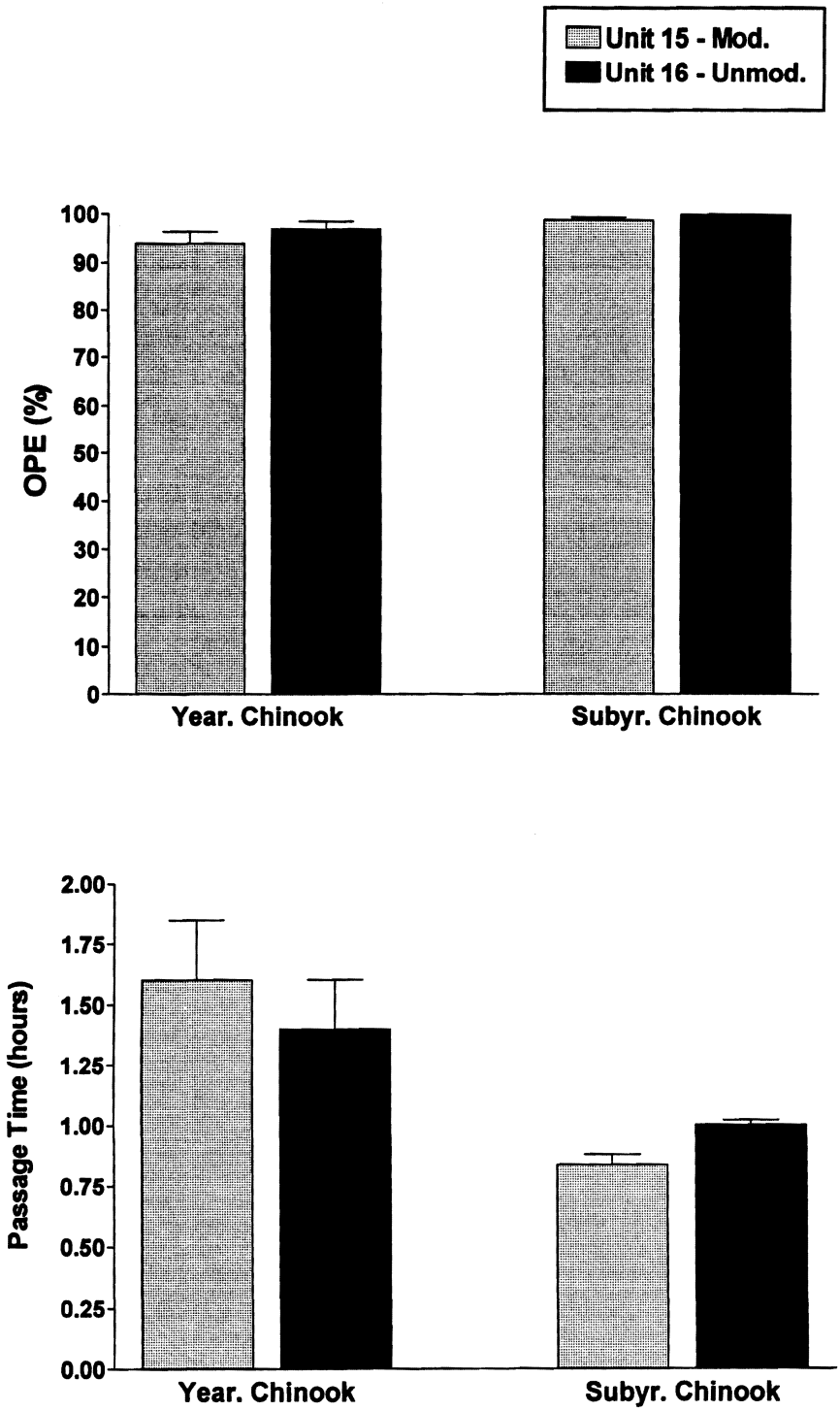


Figure 6. Orifice passage efficiency and average median passage times (with standard errors) for yearling chinook salmon during spring testing and subyearling chinook salmon during summer testing at Bonneville Dam Second Powerhouse, 2001.

Summer Testing

From 11 June to 2 July, 10 OPE replicates were conducted in the B gatewells of Units 15 and 16. OPE for subyearling chinook salmon ranged from 94 to 100% with an average of 98.7% (SE = 0.6) in Unit 15 and from 99 to 100% with an average of 99.9 (SE = 0.1) in Unit 16. The average median passage times were 0.8 and 1.0 hours for Units 15 and 16, respectively (Fig. 6). There were no significant differences in either OPE (t = 1.85, P = 0.09) or passage time (t = 0.78, P = 0.23) between the two units.

OBJECTIVE 3: EVALUATE THE EFFECTS OF A MODIFIED SCREEN SYSTEM ON JUVENILE SALMONIDS AND LAMPREY AND COMPARE TO A STANDARD UNIT

Approach

All juvenile salmon collected during FGE testing in the modified turbine unit (Unit 15, B gatewell) were examined for descaling and injury. At the same time, fish were sampled and examined from Unit 15 (A gatewell), which was also modified but did not have the gap closure device. To compare descaling and injury results from these two gatewells to each other and to a standard unit, fish were also sampled from the B gatewell of Unit 16. All fish were removed and released from Unit 16 prior to the FGE tests in Unit 15, so that fish from both units had been in the gatewells for the same amount of time (2-3 hours).

Because of increased water velocity inside the gatewells in the modified unit, it was important to determine descaling and injury rates on fish that might have been in the gatewell and exposed to this velocity for longer periods of time. Therefore, at the end of the 17-hour OPE tests, any fish recovered from Unit 15 (A and B gatewells) or 16 (B gatewell) were also examined for descaling and injury so that comparisons could be made between the three conditions; modified unit without closure device, modified unit with closure device, and unmodified unit. Fish entering gatewells during OPE tests could voluntarily exit via the orifice at any time. Therefore, not all fish examined were in the gatewell for the entire 17 hours, but a percentage were exposed to the gatewell environment for longer periods than fish examined after the FGE tests.

A fish was determined to be descaled if cumulative scale loss exceeded 20% on either side (Ceballos et al. 1992). Since the objective was to determine whether the modified gatewell environment was adversely affecting fish condition, fish with scale regeneration or fungal growth were not classified as descaled, and descaling caused by birds, when obvious, was not counted. Although the entire fish was examined for injuries, all injuries observed were to the head and were either folded operculums or eye injuries. The same personnel examined the fish throughout the study period to ensure that evaluations of descaling and injury were as consistent as possible. Three-factor analysis of variance was conducted to compare descaling rates between the three conditions.

A percentage of fish that were PIT-tagged and released into Units 15 and 16 for OPE tests were recaptured at the Smolt Monitoring Facility and examined for descaling and injury. Paired *t*-tests (paired by day) were used to compare descaling and injury rates, allowing an additional comparison of fish condition between modified and standard unit.

Results and Discussion

Spring Testing

Appendix Table 2 gives the numbers of fish examined and the numbers classified as descaled or injured in Unit 15 (A and B gatewells) and Unit 16 (B gatewell) during both the FGE (short-term) and OPE (long-term) tests. During the spring migration, there were no significant differences in descaling for yearling chinook salmon, coho salmon, or steelhead during either the short- or long-term tests (Fig. 7, Appendix Table 3). Since there were no significant differences between short- and long-term descaling, the results were combined to give overall results for each species (Table 2). Both combined descaling and injury rates were low for all species during the spring season.

As part of the OPE tests, 857 PIT-tagged yearling chinook salmon from Unit 15 and 813 from Unit 16 were recaptured using the separation-by-code system and examined for injury and descaling. There were no significant differences in percent descaling between the two units (0.23 and 0.25%, respectively, $t = 0.00029$, $P = 0.50$). Injury rates were 0% in recaptured fish from both units (Appendix Table 4).

Summer Testing

During the summer, descaling rates were also low for subyearling chinook salmon in both the short- and long-term tests (Fig. 7) with no significant differences between the three test units (Appendix Table 3). The combined short- and long-term results ranged from 1.4 to 2.1% descaling and from 0 to 0.1% injury for subyearling chinook salmon (Table 2).

As part of the OPE tests, 718 PIT-tagged subyearling chinook salmon from Unit 15 and 834 from Unit 16 were recaptured using the separation-by- code system and examined for descaling and injury. There were no significant differences in percent descaling between the two units (0.56 and 0.24%, respectively, $t = 1.02$, $P = 0.17$). Injury rates were 0% in recaptured fish from both units (Appendix Table 4).

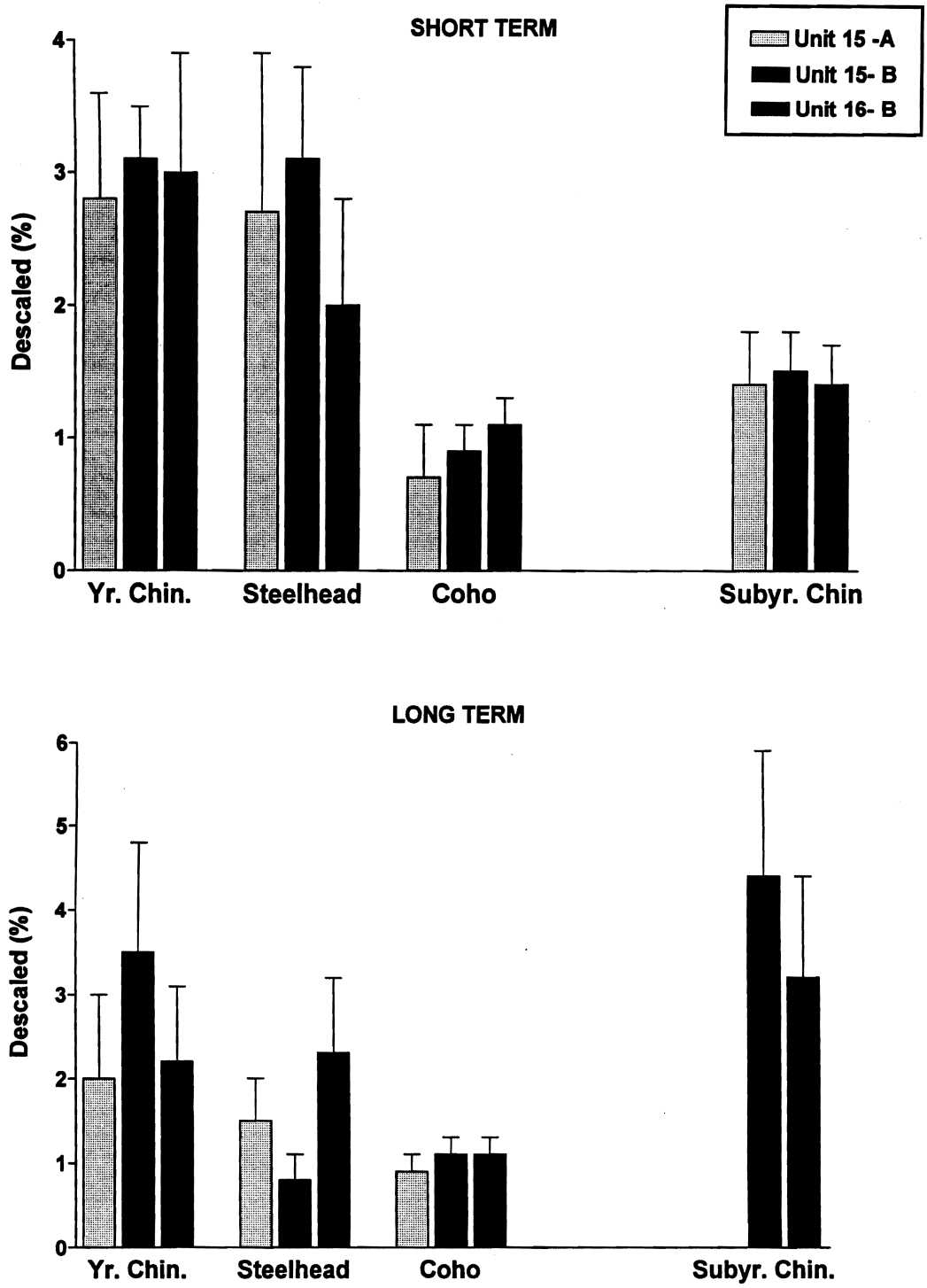


Figure 7. Short-term and long-term descaling (with standard errors) for all species examined during spring and summer testing at Bonneville Dam Second Powerhouse.

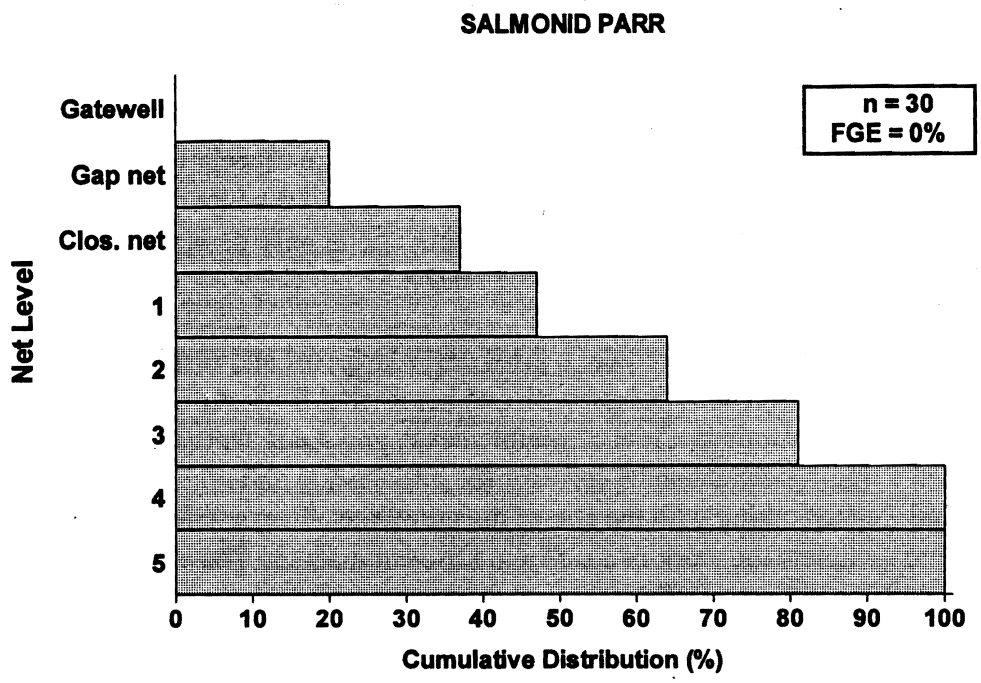
Table 2. Combined short and long-term descaling and injury rates for all species examined during fish guidance efficiency and orifice passage efficiency tests (short- and long-term combined) in a unit with an extended vertical barrier screen and turning vane (15A), a unit with an extended VBS, turning vane, and gap closure device (15B), and an unmodified unit (16B) at Bonneville Dam Second Powerhouse, 2001. Standard errors shown in parenthesis.

	Descaling (%)			Injuries (%)		
	15A	15B	16B	15A	15B	16B
Spring testing						
Yearling chinook	2.4 (0.9)	3.3 (0.5)	2.9 (0.7)	0	0.1 (0.03)	0.1 (0.03)
Steelhead	3.2 (1.2)	2.3 (0.5)	2.5 (0.9)	0	0.1 (0.02)	0.1 (0.08)
Coho	0.7 (0.3)	0.9 (0.2)	1.6 (0.4)	0	0	0
Summer testing						
Subyearling chinook	1.4 (0.4)	2.1 (0.4)	1.8 (0.3)	0.1 (0.03)	0	0.1 (0.03)

Distribution of Juvenile Lamprey and Salmonid Parr in Fish Guidance Efficiency Tests

Only 30 salmonid parr were collected during spring (29) and summer (1) FGE testing at the second powerhouse (Fig. 8; Appendix Table 5). All 30 of these fish were caught in the nets (FGE = 0%). However 20% of these fish were caught in the gap net, indicating that these fish were high enough in the water column to be guided by the STS, but were then swept over the top of the STS.

Of the 482 lamprey collected, one was collected from the gatewell and one from the gap net (Fig. 8, Appendix Table 4). The remaining fish were caught in the fyke nets, with 75% caught in net levels 3 and 4 (from elevation -3.0 m to -5.1 m msl; Fig. 3). This was comparable to results seen at Bonneville Dam First Powerhouse (Monk et al. 1999b, Monk and Sandford 2001), where most juvenile lamprey were also well below an area where they could be intercepted by the STS.



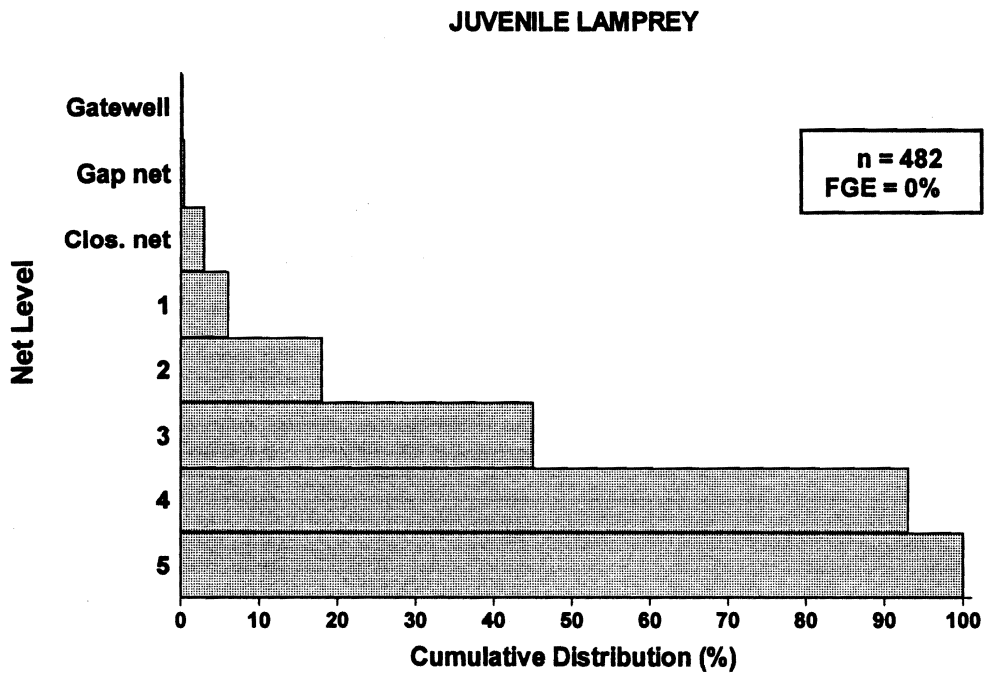


Figure 8. Cumulative distribution of salmonid parr and juvenile lamprey caught in the gap net, closure net, and fyke net levels 1 through 5.

ACKNOWLEDGMENTS

Since 1999, the Portland District COE has been committed to improving juvenile fish guidance at the Bonneville Dam Second Powerhouse. We are especially thankful to Randall Lee of the Hydraulic Design Branch and Lance Helwig of the Structural Design Branch who were instrumental in making sure the modifications were designed and installed to specifications prior to the spring testing season.

Fish guidance efficiency tests require a great deal of support and assistance from project personnel. We thank Deborah Chenowith and her staff at Bonneville Dam for this help. In particular, Gene LaDoucer, Chief of Maintenance, and Andy DeBriae, Structural Foreman, provided a rigging/maintenance crew for the initial setup and nightly testing. Crew foreman Carl Zerfing, along with the rest of the crew, was always willing to do what was needed to complete the work in a safe and efficient manner. Darrel Hunt, Chief of Operations, and the operations staff also helped coordinate unit outages and discharge levels so that the test units were operated at the required levels.

We also thank Dennis Schwartz, District Biologist, and Jennifer Sturgill and Tammy Mackey, Project Biologists, who made sure all coordination with the project was accomplished and that everyone involved was aware of what was needed to complete the study.

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APPENDIX TABLES

Appendix Table 1. Numbers of fish caught in gatewell or fyke nets (1-5) and FGE for individual replicates of tests in Unit 15B at Bonneville Dam Second Powerhouse, 2001. (SC = subyearling chinook salmon, YC = yearling chinook salmon, ST = steelhead, CO = coho, SO = Sockeye.)

	26 April					27 April					30 April				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	78	195	26	10	0	27	170	28	7	0	13	199	47	14	0
Gap Net	1	2	0	0	0	3	1	0	0	0	3	0	0	0	0
Cl. Net	36	44	0	0	0	9	69	5	1	0	8	65	8	0	0
1	13	31	0	2	0	12	23	3	0	0	2	22	2	0	0
2	43	56	5	0	0	22	67	3	0	0	9	48	4	0	0
3	28	24	0	0	0	25	23	0	0	0	4	27	0	1	0
4	7	6	0	0	0	9	6	3	0	0	6	12	0	0	0
5	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals	**206**	**361**	**31**	**12**	**0**	**107**	**359**	**42**	**8**	**0**	**45**	**373**	**61**	**15**	**0**
FGE (%)	**38**	**54**	**84**	**83**		**25**	**47**	**67**	**88**		**29**	**53**	**77**	**93**	

	1 May					2 May					3 May				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	32	481	54	45	0	12	412	48	56	0	11	389	83	39	0
Gap Net	0	4	0	0	0	0	4	0	0	0	1	0	0	0	0
Cl. Net	9	77	2	0	0	8	58	2	0	0	1	38	4	0	0
1	3	28	2	0	0	2	15	2	0	0	3	8	3	0	0
2	8	49	4	0	0	3	52	1	0	0	0	42	7	0	0
3	3	10	0	0	0	2	15	0	0	0	1	18	3	0	0
4	6	1	0	0	0	3	3	0	0	0	0	9	0	0	0
5	0	1	0	0	0	3	3	0	0	0	0	3	0	0	0
Totals	**61**	**651**	**62**	**45**	**0**	**33**	**562**	**53**	**56**	**0**	**17**	**507**	**100**	**39**	**0**
FGE (%)	**52**	**74**	**87**	**100**		**36**	**73**	**91**	**100**	**0**	**65**	**77**	**83**	**100**	

	4 May					7 May					8 May				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	7	260	81	62	0	18	312	29	73	1	13	243	47	76	0
Gap Net	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0
Cl. Net	8	42	4	0	0	3	32	3	6	0	4	36	2	4	0
1	0	18	0	0	0	4	8	0	2	0	0	9	0	2	0
2	2	56	6	1	0	0	22	2	3	0	4	12	0	2	0
3	0	20	4	0	0	0	4	0	0	0	2	5	1	1	0
4	0	12	0	0	0	0	3	0	0	0	0	9	0	0	0
5	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals	**17**	**412**	**96**	**63**	**0**	**25**	**382**	**34**	**84**	**1**	**23**	**314**	**50**	**85**	**0**
FGE (%)	**41**	**63**	**84**	**98**		**72**	**82**	**85**	**87**	**100**	**57**	**77**	**94**	**89**	

Appendix Table 1. Continued.

	9 May					10 May					11 May				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	21	240	25	22	0	33	244	20	68	0	42	254	32	77	0
Gap Net	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
Clos. Net	2	26	2	2	0	3	37	4	4	0	3	36	4	0	0
1	0	3	0	0	0	0	3	2	0	0	0	9	0	0	0
2	2	13	0	1	0	2	4	1	1	0	0	23	2	0	0
3	1	5	0	1	0	1	23	2	0	0	0	12	1	1	0
4	0	0	0	0	0	0	8	3	0	0	0	3	3	3	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals	**26**	**287**	**27**	**26**	**0**	**39**	**320**	**33**	**73**	**0**	**45**	**337**	**42**	**81**	**0**
FGE (%)	**81**	**84**	**93**	**85**		**85**	**76**	**61**	**93**		**93**	**75**	**76**	**95**	

	12 May					13 May					14 May				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	64	310	36	126	0	39	184	19	119	1	34	224	74	778	0
Gap Net	2	0	0	0	0	1	0	0	0	0	0	2	1	0	0
Cl. Net	12	46	4	7	0	10	55	2	8	0	20	40	12	95	0
1	0	4	0	3	0	3	13	0	0	0	9	14	0	18	0
2	4	22	5	1	0	1	50	5	4	0	7	22	5	43	0
3	0	11	1	0	0	1	15	1	2	0	2	14	1	14	0
4	0	3	0	0	0	3	9	0	0	0	3	0	3	12	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals	**82**	**396**	**46**	**137**	**0**	**58**	**326**	**27**	**133**	**1**	**75**	**316**	**96**	**960**	
FGE (%)	**78**	**78**	**78**	**92**		**67**	**56**	**70**	**89**	**100**	**45**	**71**	**77**	**81**	

	16 May					17 May					18 May				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	182	447	98	886	1	96	323	78	752	0	52	288	39	668	0
Gap Net	1	0	0	0	0	0	0	0	1	0	0	1	0	6	0
Cl. Net	11	23	7	54	0	8	27	7	92	0	9	35	6	133	0
1	6	12	0	24	0	2	6	2	12	0	0	10	2	31	0
2	14	29	6	50	0	5	21	2	35	0	6	32	8	61	0
3	4	15	1	26	0	1	5	0	13	0	1	15	2	23	0
4	3	0	0	18	0	0	3	0	3	0	0	12	0	21	0
5	0	0	3	3	0	0	0	0	0	0	0	3	0	0	0
Totals	**221**	**526**	**115**	**1061**	**1**	**112**	**385**	**89**	**908**	**0**	**68**	**396**	**57**	**943**	**0**
FGE (%)	**82**	**85**	**85**	**84**	**100**	**86**	**84**	**88**	**83**		**76**	**73**	**68**	**71**	

Appendix Table 1. Continued

	21 May					22 May					23 May				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	19	84	7	299	0	77	88	12	321	0	166	215	39	421	2
Gap Net	0	1	0	2	0	0	2	0	0	0	1	2	0	3	0
Cl. Net	5	24	0	41	0	20	6	0	44	0	47	22	4	47	0
1	0	3	0	9	0	3	6	0	6	0	10	6	0	15	0
2	2	4	3	20	0	14	5	0	39	0	28	23	3	34	0
3	0	4	0	6	0	17	8	0	15	0	5	5	3	7	0
4	0	6	0	0	0	9	9	0	24	0	0	3	0	0	0
5	0	0	0	3	0	4	3	0	0	0	0	0	0	3	0
Totals	**26**	**126**	**10**	**380**	**0**	**144**	**127**	**12**	**449**	**0**	**257**	**276**	**49**	**530**	**2**
FGE (%)	**73**	**67**	**70**	**79**		**53**	**69**	**100**	**71**		**65**	**78**	**80**	**79**	**100**

	11 June					12 June					13 June				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	151	54	3	1	3	241	177	18	3	6	370	42	3	3	3
Gap Net	3	0	0	0	0	2	0	0	0	0	5	1	0	0	0
Cl. Net	46	12	0	4	0	28	1	0	0	2	92	9	2	0	1
1	15	1	0	0	0	4	0	0	0	0	22	0	0	0	0
2	19	5	0	0	0	8	0	0	0	0	71	1	0	1	0
3	9	1	0	1	0	0	2	0	0	0	13	2	0	0	0
4	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals	**253**	**73**	**3**	**6**	**3**	**283**	**180**	**18**	**3**	**8**	**573**	**55**	**5**	**4**	**4**
FGE (%)	**60**	**74**	**100**	**17**	**100**	**85**	**98**	**100**	**100**	**75**	**65**	**76**	**60**	**75**	**75**

	14 June					15 June					18 June				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	225	24	0	1	0	309	39	1	9	0	167	11	3	8	3
Gap Net	1	0	0	0	0	2	0	0	0	0	3	0	0	0	0
Cl. Net	42	3	0	1	0	72	6	0	0	0	50	1	0	0	0
1	7	0	0	0	0	12	2	0	0	0	9	0	0	0	0
2	40	0	0	0	0	38	0	0	0	0	40	0	0	1	0
3	15	0	0	0	0	17	1	0	0	1	28	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals	**330**	**27**	**0**	**2**	**0**	**450**	**48**	**1**	**9**	**1**	**301**	**12**	**3**	**9**	**3**
FGE (%)	**68**	**89**		**50**		**69**	**81**	**100**	**100**	**0**	**55**	**92**	**100**	**89**	**100**

Appendix Table 1. Continued.

	19 June					20 June					21 June				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	210	7	2	0	1	157	16	2	2	3	119	27	1	2	1
Gap Net	2	0	0	0	0	0	1	0	0	0	4	0	0	0	0
Cl. Net	66	2	0	0	1	61	4	0	0	2	97	6	0	1	2
1	16	2	0	0	0	7	5	3	0	0	30	0	0	0	0
2	22	0	0	0	0	44	2	0	0	2	67	3	0	0	1
3	9	0	0	0	0	22	0	0	0	2	23	0	0	0	2
4	3	0	0	0	0	12	0	0	0	0	12	3	0	0	0
5	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
Totals	**328**	**11**	**2**	**0**	**2**	**306**	**28**	**5**	**2**	**9**	**352**	**39**	**1**	**3**	**6**
FGE (%)	**64**	**64**	**100**		**50**	**51**	**57**	**40**	**100**	**33**	**34**	**69**	**100**	**67**	**17**

	22 June					26 June					27 June				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	204	28	5	3	2	116	7	2	0	3	262	2	1	2	2
Gap Net	3	1	0	0	0	0	0	0	0	0	2	0	0	0	0
Cl. Net	57	3	0	0	0	76	9	0	0	0	258	11	0	3	3
1	22	3	0	0	0	21	3	0	0	0	49	9	0	0	0
2	24	2	1	0	0	42	9	0	0	0	168	12	2	0	7
3	11	1	0	0	0	20	0	1	0	0	84	9	1	0	1
4	1	0	0	0	0	15	0	0	0	0	42	3	0	0	0
5	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0
Totals	**322**	**38**	**6**	**3**	**2**	**290**	**28**	**3**	**0**	**3**	**874**	**46**	**4**	**5**	**13**
FGE (%)	**63**	**74**	**83**	**100**	**100**	**40**	**25**	**67**		**100**	**30**	**4**	**25**	**40**	**15**

	28 June					29 June					1 July				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	155	18	1	6	4	133	5	2	1	3	238	47	3	3	2
Gap Net	5	1	0	0	0	0	0	0	0	0	11	0	0	0	0
Cl. Net	50	3	0	0	0	56	2	0	0	0	190	16	1	0	2
1	4	0	0	0	1	16	0	0	0	0	45	0	0	0	0
2	29	0	0	0	0	51	4	0	0	0	127	6	1	0	1
3	6	0	0	0	1	21	1	0	0	0	50	5	0	0	0
4	0	0	0	0	0	12	0	0	0	0	6	9	0	0	0
5	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0
Totals	**249**	**22**	**1**	**6**	**6**	**289**	**12**	**2**	**1**	**3**	**673**	**83**	**5**	**3**	**5**
FGE (%)	**62**	**82**	**100**	**100**	**67**	**46**	**42**	**100**	**100**	**100**	**35**	**57**	**60**	**100**	**40**

Appendix Table 1. Continued

	2 July					9 July					10 July				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	146	4	0	0	0	121	5	0	0	1	690	20	3	3	0
Gap Net	9	2	0	0	0	0	0	0	0	0	9	0	0	0	0
Cl. Net	14	0	0	0	0	39	4	0	0	0	156	6	0	0	0
1	12	0	0	0	0	15	0	0	0	0	46	0	0	0	0
2	18	1	0	0	0	29	2	0	0	0	124	8	0	0	0
3	10	0	0	0	0	17	0	0	0	0	66	2	0	0	0
4	9	0	0	0	0	21	0	0	0	0	27	3	0	0	0
5	0	0	0	0	0	6	0	0	0	0	6	0	0	0	0
Totals	**218**	**7**	**0**	**0**	**0**	**248**	**11**	**0**	**0**	**1**	**1124**	**39**	**3**	**3**	**0**
FGE (%)	**67**	**57**				**49**	**45**			**100**	**61**	**51**	**100**	**100**	

	11 July					12 July				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	300	8	0	0	0	194	4	0	1	0
Gap Net	0	0	0	0	0	1	0	0	0	0
Cl. Net	40	3	0	0	0	38	1	0	0	0
1	14	3	0	0	0	24	0	0	0	0
2	36	0	0	0	0	26	0	0	0	0
3	15	0	0	0	0	45	0	0	0	0
4	15	0	0	0	0	24	0	0	0	0
5	0	0	0	0	0	15	0	0	0	0
Totals	**420**	**14**	**0**	**0**	**0**	**367**	**5**	**0**	**1**	**0**
FGE (%)	**71**	**57**				**53**	**80**		**100**	

Appendix Table 2. Numbers of fish examined and numbers classified as descaled, or with injuries during FGE (short-term) and OPE (long-term) tests in Units 15A (modified without gap closure device), 15B (modified with gap closure device), and 16B (not modified) at Bonneville Dam Second Powerhouse, 2001.

Yearling chinook salmon: Short-term

	Unit 15A			Unit 15B			Unit 16B		
Date	No. Exam	Desc.	Injury	No. Exam	Desc.	Injury	No. Exam	Desc.	Injury
26 April	73	4	0	195	9	0	107	13	0
27 April	92	13	0	170	17	0	167	20	0
30 April	74	0	0	199	3	0	543	9	0
1 May	49	0	0	481	6	0	200	1	0
2 May	250	6	0	412	11	0	256	4	0
3 May	235	4	0	389	7	0	250	5	0
4 May	70	0	0	260	5	0			
7 May	113	2	0	312	7	0	217	3	0
8 May	155	2	0	243	5	0	145	3	0
9 May	135	3	0	240	8	0	253	8	0
10 May	161	6	0	244	6	0	279	6	0
11 May	175	4	0	254	5	0	265	2	0
12 May	150	1	0	310	9	0	119	1	0
13 May	148	2	0	184	1	0	233	2	0
14 May	71	2	0	224	5	1	122	3	1
16 May				447	15	1	11	0	0
17 May				323	11	0	15	0	0
18 May				288	11	0	85	3	0
21 May	73	2	0	84	4	0	36	1	3
22 May	72	1	0	88	3	0	8	0	0
23 May	76	4	0	215	12	0	6	0	0

Yearling chinook salmon: Long-term

	Unit 15A			Unit 15B			Unit 16B		
Date	No. Exam	Desc.	Injury	No. Exam	Desc.	Injury	No. Exam	Desc.	Injury
2 May	223	0	0	625	3	0	415	2	0
3 May	269	2	0	508	8	2	395	11	0
4 May							142	0	0
7 May							384	6	0
9 May	326	8	0	302	10	0			
11 May	282	2	0	315	8	0	285	7	0
12 May	151	1	0	318	2	0	276	11	0
16 May	106	1	0				156	1	0
17 May				66	1	0	60	0	0
22 May				99	13	0	24	2	0
23 May	52	4	0	82	5	0	85	2	0

Appendix Table 2. Continued

Steelhead: Short-term

	Unit 15A			Unit 15B			Unit 16B		
Date	No. Exam	Desc.	Injury	No. Exam	Desc.	Injury	No. Exam	Desc.	Injury
26 April	6	0	0	26	0	0	12	2	0
27 April	18	2	0	28	1	0			
30 April	17	2	0	47	1	0	78	2	0
1 May	5	0	0	54	1	0	6	0	0
2 May	41	1	0	48	1	0	9	0	0
3 May	29	0	0	83	1	0	38	0	0
4 May	16	0	0	81	2	0			
7 May	11	0	0	29	2	0	8	0	0
8 May	22	0	0	47	2	0	24	2	0
9 May	11	0	0	25	3	0	15	0	0
10 May	36	1	0	20	1	0	23	1	0
11 May	24	0	0	32	1	0	18	0	0
12 May	17	0	0	36	0	0	26	1	0
13 May	17	2	0	19	0	0	44	0	0
14 May	30	0	0	74	2	0	4	0	0
16 May				98	4	0	19	0	0
17 May				78	2	0	15	0	0
18 May				39	3	0	36	1	0
21 May	6	0	0	7	0	0	4	0	0
22 May	36	0	0	12	0	0	8	0	0
23 May	22	2	0	39	1	0	20	0	0

Steelhead: Long-term

	Unit 15A			Unit 15B			Unit 16B		
Date	No. Exam	Desc.	Injury	No. Exam	Desc.	Injury	No. Exam	Desc.	Injury
25 April	11	2	0	3	0	0	9	0	0
2 May	92	0	0	201	1	0	42	1	0
3 May	75	0	0	192	1	0	36	1	0
4 May							76	0	0
9 May	79	3	0	75	2	0	26	0	0
11 May	24	0	0	34	0	0	15	0	0
12 May	78	1	0	123	1	0	13	2	0
16 May	32	0	0	138	1	1	38	0	1
17 May				65	0	0	9	0	0
22 May				94	1	0	28	0	0
23 May	101	3	0	104	1	0	26	3	0

Appendix Table 2. Continued

Coho salmon: Short-term

	Unit 15A			Unit 15B			Unit 16B		
Date	No. Exam	Desc.	Injury	No. Exam	Desc.	Injury	No. Exam	Desc.	Injury
26 April	5	0	0	10	0	0	15	1	0
27 April							14	1	0
30 April	4	0	0	14	0	0	71	1	0
1 May	3	0	0	45	0	0	7	0	0
2 May	34	0	0	56	0	0	22	1	0
3 May	16	0	0	39	0	0	18	0	0
4 May	10	0	0	62	2	0	63	1	0
7 May	20	0	0	73	1	0	101	3	0
8 May	44	0	0	76	2	0	41	1	0
9 May	15	0	0	22	0	0	19	0	0
10 May	67	3	0	77	1	0	106	1	0
11 May	47	0	0	77	1	0	106	1	0
12 May	63	0	0	126	1	0	187	2	0
13 May	52	0	0	119	0	0	377	2	0
14 May	123	2	0	778	7	1	381	0	0
16 May				886	10	0	524	4	0
17 May				752	9	0	577	2	0
18 May				668	8	0	1,060	8	0
21 May	263	0	0	299	5	0	1,000	13	3
22 May	1,019	4	0	321	2	0	338	0	0
23 May	301	5	0	421	0	0	329	1	0

Coho salmon: Long-term

	Unit 15A			Unit 15B			Unit 16B		
Date	No. Exam	Desc.	Injury	No. Exam	Desc.	Injury	No. Exam	Desc.	Injury
25 April	10	0	0	3	0	0	40	0	0
2 May	102	1	0	160	0	0	238	2	0
3 May	65	1	0	71	0	0	111	2	0
9 May	105	1	0	74	1	0	242	1	0
11 May	148	1	0	153	2	0	174	2	0
12 May	304	1	0	299	6	0	382	6	0
14 May							1,233	9	1
16 May	782	1	0	1,615	27	1	613	5	0
17 May				422	7	0			
22 May				1,374	12	0	696	5	0
23 May	845	9	0	1,175	11	0	1,067	17	0

Appendix Table 2. Continued

Subyearling chinook salmon: Short-term

	Unit 15A			Unit 15B			Unit 16B		
Date	No. Exam	Desc.	Injury	No. Exam	Desc.	Injury	No. Exam	Desc.	Injury
11 June				151	0	0	189	0	0
12 June				241	0	0	97	0	0
13 June	219	0	0	370	1	0	89	0	0
14 June	58	2	0	225	2	0	290	3	0
15 June	240	15	0	309	2	0	442	6	1
18 June	108	1	0	167	2	0	299	4	0
19 June	127	0	0	210	6	0	344	0	0
20 June	67	0	0	157	2	0	139	2	0
21 June	132	0	0	119	0	0	214	0	0
22 June	115	0	0	204	4	0	259	5	0
26 June	103	3	0	116	3	0	320	10	0
27 June	179	6	0	262	5	0	214	12	0
28 June	164	4	0	155	3	0	332	7	0
29 June	133	1	0	133	5	0	189	4	1
1 July	199	2	1	238	6	0	189	1	1
2 July	77	0	0	146	0	0	126	1	0
9 July	89	0	0	121	2	0	273	6	0
10 July	221	5	0	688	12	0	536	9	0
11 July	82	1	0	300	9	0	776	12	0
12 July	59	0	0	194	2	0	318	4	0

Subyearling chinook salmon: Long-term

	Unit 15A			Unit 15B			Unit 16B		
Date	No. Exam	Desc.	Injury	No. Exam	Desc.	Injury	No. Exam	Desc.	Injury
12 June				616	2	0	337	0	0
14 June	215	9	0	202	20	0	213	16	0
15 June				201	3	0	307	1	0
19 June				108	13	0	124	9	0
20 June				51	0	0	131	10	0
21 June				105	4	0	77	0	0
27 June				266	6	0	193	5	0
28 June							212	15	0
29 June				80	6	0	94	0	0
3 July				42	1	0	125	0	0

Appendix Table 3. Results of ANOVA tests comparing Units 15A (modified without gap closure device), 15B (with all three modifications), and 16B (no modifications) for all species tested during short-term and long-term descaling tests.

SPRING TESTING

Yearling chinook salmon: Short-term

	15A	15B	16B
mean	2.7	3.1	3.0
SE	0.8	0.4	0.9

ANOVA

Source	DF	SS	MS	F	P
Unit/slot	2	1.58	0.79	0.09	0.914
Error	52	453.46	8.72		
Total	54	455.04			

Yearling chinook salmon: Long-term

	15A	15B	16B
mean	2.1	3.5	2.2
SE	0.9	1.3	0.9

ANOVA

Source	DF	SS	MS	F	P
Unit/slot	2	10.37	5.18	0.52	0.600
Error	23	227.89	9.91		
Total	25	238.33			

Steelhead: Short-term

	15A	15B	16B
mean	2.7	3.1	2.0
SE	1.2	0.6	0.8

ANOVA

Source	DF	SS	MS	F	P
Unit/slot	2	6.93	3.47	0.51	0.609
Error	29	199.01	6.86		
Total	31	205.94			

Steelhead: Long-term

	15A	15B	16B
mean	1.5	0.8	2.3
SE	0.5	0.3	0.9

ANOVA

Source	DF	SS	MS	F	P
Unit/slot	2	8.56	4.28	2.03	0.160
Error	18	37.87	2.1		
Total	20	46.46			

Appendix Table 3. Continued

Coho Salmon: Short-term

	15A	15B	16B
mean	0.7	0.9	1.1
SE	0.4	0.2	0.2

ANOVA

Source	DF	SS	MS	F	P
Unit/slot	2	1.13	0.56	0.52	0.589
Error	41	43.06	1.05		
Total	43	44.19			

Coho Salmon: Long-term

	15A	15B	16B
mean	0.8	1.1	1.1
SE	0.2	0.2	0.2

ANOVA

Source	DF	SS	MS	F	P
Unit/slot	2	0.36	0.18	0.52	0.599
Error	22	7.53	0.34		
Total	24	7.89			

SUMMER TESTING

Subyearling chinook salmon: Short-term

	15A	15B	16B
mean	1.4	1.5	1.4
SE	0.4	0.3	0.3

ANOVA

Source	DF	SS	MS	F	P
Unit/slot	2	0.1	0.05	0.02	0.976
Error	55	110.51	2.01		
Total	57	110.61			

Subyearling chinook salmon: Long-term

	15A	15B	16B
mean		4.4	3.2
SE		1.5	1.2

ANOVA

Source	DF	SS	MS	F	P
Unit/slot	1	6.5	6.5	0.41	0.531
Error	17	270.6			
Total	18	277			

Appendix Table 4. Results of descaling and injury examinations on PIT-tagged yearling and subyearling chinook salmon released into Units 15 and 16 and recovered at Bonneville Dam Second Powerhouse Downstream Monitoring Facility.

Spring - Yearling chinook salmon

			Descaling		Injury	
Date	Unit	No. Examined	No.	%	No.	%
4/24	15B	52	0	0	0	0.0
5/1	15B	95	0	0	0	0.0
5/1	16B	95	0	0	0	0.0
5/2	15B	70	0	0	0	0.0
5/2	16B	86	1	1.2	0	0.0
5/7	15B	93	0	0	0	0.0
5/7	16B	97	0	0	0	0.0
5/8	15B	74	0	0	0	0.0
5/8	16B	93	0	0	0	0.0
5/10	15B	95	0	0	0	0.0
5/10	16B	85	0	0	0	0.0
5/11	15B	84	0	0	0	0.0
5/11	16B	100	0	0	0	0.0
5/15	15B	90	1	1.1	0	0.0
5/15	16B	96	1	1.0	0	0.0
5/16	15B	88	1	1.1	0	0.0
5/16	16B	95	0	0	0	0.0
5/21	15B	71	0	0	0	0.0
5/21	16B	27	0	0	0	0.0
5/22	15B	45	0	0	0	0.0
5/22	16B	39	0	0	0	0.0

Summer - Subyearling chinook salmon

			Descaling		Injury	
Date	Unit	No. Examined	No.	%	No.	%
6/13	15B	88	0	0	0	0
6/13	16B	92	0	0	0	0
6/14	15B	90	0	0	0	0
6/14	16B	94	0	0	0	0
6/18	15B	82	0	0	0	0
6/18	16B	91	0	0	0	0
6/19	15B	89	1	1.1	0	0
6/19	16B	90	0	0	0	0
6/20	15B	82	0	0	0	0
6/20	16B	99	1	1.0	0	0
6/26	15B	81	2	2.5	0	0
6/26	16B	98	0	0	0	0
6/27	15B	83	0	0	0	0
6/27	16B	96	0	0	0	0
6/28	15B	62	1	1.6	0	0
6/28	16B	80	1	1.2	0	0
7/2	15B	61	0	0	0	0
7/2	16B	94	0	0	0	0

Appendix Table 5. Numbers of juvenile lamprey and salmonid parr caught in gatewell or fyke nets (1-5) and FGE for individual replicates of tests in Unit 15B from 26 April to 12 July at Bonneville Dam Second Powerhouse, 2001.

	Lamprey									
	4/26	4/27	4/30	5/1	5/2	5/3	5/4	5/7	5/8	5/9
Gatewell	0	0	0	0	0	0	0	0	0	0
Gap net	0	0	0	0	0	0	0	0	0	0
Clos. net	2	0	0	0	0	0	2	0	0	0
1	0	0	1	1	0	0	0	0	3	0
2	0	2	4	7	4	4	4	4	0	0
3	2	2	6	19	9	11	9	11	8	3
4	9	12	6	48	24	12	12	6	0	3
5	3	0	12	6	3	3	0	3	0	6
Totals	**16**	**16**	**29**	**81**	**40**	**30**	**27**	**24**	**11**	**12**
FGE (%)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	5/10	5/11	5/12	5/13	5/14	5/16	5/17	5/18	5/21	5/22	5/23
Gatewell	0	0	0	0	0	0	0	0	0	0	0
Gap Net	0	0	0	0	0	0	0	0	0	0	0
Clos. net	2	0	1	2	0	1	1	0	0	0	0
1	1	0	1	1	0	0	0	1	0	0	0
2	4	0	2	0	1	0	0	2	0	3	3
3	9	1	6	4	3	1	2	2	0	1	2
4	3	6	3	15	3	3	3	0	0	9	3
5	3	0	0	0	3	0	0	0	3	0	0
Totals	**22**	**7**	**13**	**22**	**10**	**5**	**6**	**5**	**3**	**13**	**8**
FGE (%)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	6/11	6/12	6/13	6/14	6/15	6/18	6/19	6/20	6/21	6/22	
Gatewell	0	0	0	0	1	0	0	0	0	0	
Gap net	0	0	0	0	0	0	1	0	0	0	
Clos. net	0	0	0	0	0	0	0	0	0	0	
1	1	2	1	0	0	0	0	0	0	0	
2	1	0	4	1	1	0	0	2	2	0	
3	0	1	2		0	0	2	1	4	0	
4	0	6	2		0	3	9	0	9	3	
5	3	0	0	1	0	0	0	0	0	3	
Totals	**5**	**9**	**9**	**2**	**2**	**3**	**12**	**3**	**15**	**6**	
FGE (%)	**0**	**0**	**0**	**0**	**50**	**0**	**0**	**0**	**0**	**0**	

Appendix Table 5. Continued.

	Lamprey									
	6/26	6/27	6/28	6/29	7/1	7/2	7/9	7/10	7/11	7/12
Gatewell	0	0	0	0	0	0	0	0	0	0
Gap net	0	0	0	0	0	0	0	0	0	0
Clos. net	2	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
2	3	0	0	0	1	1	0	1	0	0
3	2	0	0	0	1	0	0	0	0	0
4	0	3	3	0	0	3	0	0	0	6
5	0	0	0	0	0	0	0	0	0	0
Totals	**7**	**3**	**3**	**0**	**2**	**4**	**0**	**1**	**0**	**6**
FGE (%)	**0**	**0**	**0**		**0**	**0**		**0**	**??**	**0**

	Salmonid parr									
	4/26	4/27	4/30	5/1	5/2	5/3	5/4	5/7	5/8	5/9
Gatewell	0	0	0	0	0	0	0	0	0	0
Gap Net	1	0	0	0	0	0	0	5	0	0
Clos. Net	2	0	0	1	0	0	0	1	0	0
1	0	2	0	1	0	0	0	0	0	0
2	1	2	0	0	0	0	0	1	1	0
3	1	0	0	0	0	0	0	1	0	0
4	0	0	0	0	0	0	0	3	0	0
5	0	0	0	0	0	0	0	0	0	0
Totals	**5**	**4**	**0**	**2**	**0**	**0**	**0**	**11**	**1**	**0**
FGE (%)	**0**	**0**		**0**				**0**	**0**	
	5/10	5/11	5/12	5/13	5/14	5/16	5/17	5/18	5/21	5/22
Gatewell	0	0	0	0	0	0	0	0	0	0
Gap net1	0	0	0	0	0	0	0	0	0	0
Clos net	0	1	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	1	1	0	0
4	0	0	0	0	0	0	0	3	0	0
5	0	0	0	0	0	0	0	0	0	0
Totals	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**4**	**0**	**0**
FGE (%)		**0**					**0**	**0**		

Appendix Table 5. Continued

	Salmonid parr									
	5/23	6/11	6/12	6/13	6/14	6/15	6/18	6/19	6/20	6/21
Gatewell	0	0	0	0	0	0	0	0	0	0
Gap net1	0	0	0	0	0	0	0	0	0	0
Clos net	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	1	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
Totals	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
FGE (%)									**0**	
	6/22	6/26	6/27	6/28	6/29	7/1	7/2	7/9	7/10	7/11	7/12
Gatewell	0	0	0	0	0	0	0	0	0	0	0
Gap net1	0	0	0	0	0	0	0	0	0	0	0
Clos net	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
Totals	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
FGE (%)											